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Evaluating critical barriers to implementation of WEEE management using DEMATEL approach

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ABSTRACT

The generation of waste of electrical and electronic equipment (WEEE) has increased proportionally across the world, and the developed countries due to regulatory pressures have made technological upgradations and practices to manage this huge quantity of waste. However, the developing countries like India are facing numerous hurdles in managing the huge quantity of WEEE. Therefore, this study aims to first identify the barriers of WEEE management in the context of India and subsequently analyze those barriers that need to be addressed urgently to manage this issue. Through extensive literature review, expert inputs, we have identified seven primary barriers and forty-four sub-barriers and then rationalize with various socio-economic theories. Decision Making Trial and Evaluation Laboratory (DEMATEL) is applied in this study to prioritize the barriers and then identify the interdependence of these barriers on each other. The results indicate that the policy and regulatory barriers and the infrastructural barriers are the prominent barriers for effective management of WEEE. Further, the results obtained through DEMATEL analysis indicate that the policy and regulatory barriers as well as the socio economic barriers are the most prominent barriers with maximum driving effect on the overall system.

1. Introduction

Globally, increasing population, advanced industrialization and developing economies contribute to the rapid increase in waste, thereby amplifying the complexity and hazardous nature of waste. Developing nation like India has successfully gleaned the financial development, the production and consumption of its population extremely harms the standard of ecosystems and the respectability of its regular assets. India is emerging as one of the world’s leading nation the generates waste of electrical and electronic equipment (WEEE) and it is expected to produce 5.2 million metric tonnes (MT) of such waste annually by the year 2020 from the current level of 1.85 million MT; thereby demonstrating a compound annual growth rate (CAGR) of about 30% (Garlapati, 2016). The rapid flow of WEEE causes threat to human lives and ecosystem because of the toxic and hazardous nature. For these numbers, we can determine that there is a significant need for implementing WEEE management within Indian context and thus reduce the risk of huge WEEE generation. However, it improves the institutional, organizational, ecological, economical, and the agonistic performance level of the system.

Almost 80% of WEEE is illegally exported from developed to developing nations like India, China, Nigeria, Pakistan, Philippines, Sri Lanka, Vietnam, Thailand and some part of West Africa, because of accessibility of inexpensive workmanship and lack of stringent regulation and norms (Pradhan and Kumar, 2014; Sthiannopkao and Wong, 2013; Skinner et al., 2010; Schwarzer et al., 2005). India is a primary dumping site for WEEE from the developed nations. The reason behind it is the delay in law enforcement on producers or manufacturers, so as to come up with efficient management for handling returns and proper disposal of electronic products (Toxic Link, 2014; Sinha-Khetriwal et al., 2005; Lambert et al., 2011; Dwivedy and Mittal, 2013). Lack of strategies for recovery of resources and sanitary landfills has become prominent barriers behind un-segregating WEEE, thus challenging limited recycling and disposal option. As per MAIT-GTZ (2007), almost 95% of total WEEE in India is assembled and recycled by unorganized subdivision that carry out operations like rare metal recovery and extraction of reused parts by environment unfriendly manner in the country. Informal sector is an entirely new profitable sector that involves WEEE trading, refurbishing, repairing, and extracting materials from obsolete electronic devices and provides a livelihood for poor and migrated people; however, it can cause many problems on aquatic system and human health (Awasthi et al., 2016a,b; Kwatra et al., 2014; Imran et al., 2017; Song and Li, 2014a,b; Song and Li, 2015).

Several barriers possibly hinder the adoption and implementation of WEEE management; these barriers are government policies, consumer attitude, technological gaps, stakeholders role, globalization and...
economic consideration between formal and informal sector (Qu et al., 2013; Estrada-Ayub and Kahhat, 2014; Milovantseva and Fitzpatrick, 2015). For effective adoption of WEEE management activities, there are various reasons; but the presence of obstacles makes WEEE management challenging and the effect of these barriers cannot be overcome at the same time. Furthermore, the identical barrier requires different priorities of treatment depending on the variation in the characteristics of resources, strategies, and capabilities of the management of the organization. The mismanagement in handling WEEE can create tremendous negative impact on the ecological and economic performances of organizations (Robinson, 2009). By contrast, in developing nations WEEE management still to be an immature practice (Hung Lau and Wang et al. 2009). In the view of above statistics and information, there is an urgent need to have sufficient infrastructure, cleaner technologies, and inviolable legal policies for effective WEEE management in India. In developing countries, there are plenty of indications in respects of public willingness for recycling, consumer awareness, policies and regulation, and participation of stakeholders, however, some criticalities are observed while implementing effective WEEE management practices. It is well known that WEEE management is mandatory for maintaining economic, environmental and social norms in the developed and developing nations.

Given the importance to WEEE management, this study addresses the critical gap in literature. First, it develops a theoretical model to study the barriers to WEEE management which are supported by six socio-economic theories such as transaction cost economic (TCE), resource based theory (RBT), theory of planned behavior (TPB), institutional theory (INT), social network theory (SNT) and stakeholder theory (ST). Second, it identifies the critical barriers could be used for developing strategies for implementing WEEE management in India.

The justification behind the proposed study is to empirically understand the critical barriers that hinders the implementation of WEEE management in the Indian context, which is considered because India is massive growing developing nation and most anticipating economies in the world (Carisma, 2009; Jindal and Sangwan, 2011; Rathore et al., 2011).

This research raises some questions for analysis as follows:

I What are the critical barriers need to be considered for successful implementation of WEEE management?
II How to prioritize the critical barriers for successful implementation of WEEE management?
III How to determine the cause and effect relationship among the identified barriers for successful adoption of WEEE management?

The purpose of the study is to use the cognition mapping process for identifying the critical barriers in designing and implementing WEEE management and investigating their causal relationship with the support of multi-criteria decision making analysis (MCDA) through a proposed framework model. Here Decision-Making Trial and Evaluation Laboratory (DEMATEL) methodology has been used to evaluate the barriers. The DEMATEL methodology (Gabus and Fontela, 1972) can be used to prioritize and establish the cause and effect relationship among the barriers in the adoption of WEEE management. DEMATEL can assist policy makers to establish the strategies for efficient handling of the WEEE management system (Kharat et al., 2016; Kusi-Sarpong et al., 2016).

The paper is organized in the following manner. Segment 2 briefly reviews the literature review and theoretical foundations to study the barriers hindering the adoption of WEEE management in India and highlights the research gaps of the study. DEMATEL methodology is presented in Section 3. Section 4 presents the proposed research framework and Section 5 puts forth an illustrative case study and application by using proposed methodology. Section 6 thoroughly discusses the results of empirical study, and Section 7 demonstrated the managerial implication of the study. Finally, the conclusion is given in Section 8.

2. Literature review

This section highlights the theoretical foundation, importance of MCDA techniques in waste management, implementation barriers in WEEE management and the research gaps explored in this study.

2.1. Theoretical foundation

This research is explicitly grounded on the basis of the socio-economic theories which provide suitable platform to support the issue and add to understanding the validity of such arrangement with respect to barriers hindering the implementation of WEEE management in India. Literature suggests that a single theoretical foundation is not sufficient to explain issues relating to the adoption of EoL product recovery management. For example, Boudier and Bensebaa (2011), suggest theories including transaction cost economic (TCE), institutional theory (INT) and stakeholder theory (ST) to explain how cost constraints on waste management and recycling activities in developed nation coupled with socially irresponsible behavior. Several studies have used theory of planned behavior (TPB) to investigate the relationship between attitude and willingness to support policy measures on household waste recycling (Tonglet et al., 2004; Omran et al., 2009; Nghur et al., 2010; Mahmud and Osman, 2010; Pakpour et al., 2014; Wan et al., 2015). A study by Hung Lau and Wang (2009) suggest that combination of complementary theories like transaction cost economic (TCE) and resource based theory (RBT) have been used to assist firms in choosing an end of life product recovery management system. Similarly, Sarkis et al. (2010) investigated similarities and differences derived from the nine theoretical perspective such as Stakeholder theory (ST); Ecological Modernization theory (EMT); Information theory; Complexity theory (CT); Resource Dependence theory (RDT); Institutional theory; Resource Based View (RBV); Social Network theory (SNT), and Transaction Cost Economics (TCE) theory in their adoption of green supply chain management (GSCM) practices. A recent study by Rahman et al. (2017) have used three theories such as TCE, RBT and neo-institutional theory (NIT) as theoretical underpinning to rationalize the challenges faced by multinational third-party logistics (MN3PL) operating in china. However, there is still lack of theoretically grounded research for waste management in India. Even though when there are some studies relying on certain theories but they solely rely on that particular theory to explain the phenomena (Hazar et al., 2013; Khan et al., 2014; Dubey et al., 2017; Venkatssan and Annamalai, 2017). Given the related complexity in India, using multiple theories may be helpful to obtain wider perspectives of barriers to WEEE management implementation. At last, we consider six theories such as transaction cost economics (TCE), resource-based theory (RBT), theory of planned behavior (TPB), institutional theory (INT), social network theory (SNT) and stakeholder theory (ST) as theoretical foundation of our study. An overview of the theoretical foundation and relevant barriers are shown in Table 2. In the following sub-sections we briefly discuss each of these theories and discuss the rationale for their application in the context of barriers to the implementation of WEEE management in India. Table 2 Depicted the socio-economic theories related to barriers of the WEEE management in India.

2.1.1. Transaction cost economics (TCE)

The theory of transaction cost economics (TCE) is generally accepted framework for analyzing return management and outsourcing arrangement that minimizes costs associated with various firm transactions such as market based exchange, legal costs of establishing contracts, costs associated with return management of obsolete electronic goods, monitoring costs, sales taxes etc. (Barthélemy and Quelin, 2006; Cao and Zhang et al., 2011; Rahman and Jim Wu, 2011; Skjoett-Larsen, 2000; Yang and Huang, 2000; Zacharia et al. 2011). Additionally, economic performance improvement can result in environmental performance improvement due to waste reduction and resources
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